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DYNAMICS OF PLANKTON POPULATIONS
IN UPWELLING AREAS

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By the time delay in processing ERTS-1 data we obtained a complete coverage of our test areas during the last weeks. Quality of processed prints and transparencies are excellent. Unfortunately, the gray scale for prints was readjusted which is in favor for geological studies (features with high reflectance) but decreases the contrast between water masses with different plankton concentrations.

The analysis of the ground truth data collected with the "Jean Charcot" and "Cornide de Saveedra" are finished and will be ready for the final art work. In our recent activity we are focusing on the analysis of data recorded over the test site along the Northwest Coast of Africa. Repeated coverage of the test site showed that the structure of chlorophyll distribution is much more complicated than we expected from our continuous recordings. ERTS data showed a very fast change in the chlorophyll distribution and it seems that also the concentration changes quickly.

ERTS-1 showed on some frames offshore transportation of dust from the Sahara. All frames from Channel 7 will be arranged as a montage to derive the transportation pattern of dust transportation.

This step is important in our biological aspects to interpret ERTS-1 data, because the dissolution kinetics of eolian dust particles may influence significantly the chemistry of the surface water.

Since visibility and the biochemistry of our test site along the Northwest Coast of Africa is influenced by the dust transport, we included in our ground truth program in February through March a dust collection.

Besides chlorophyll and other hydrographical parameters, the dust load in that area will be measured. A detailed description of the program is attached.

PROJECT DESCRIPTION

CHEMICAL EFFECTS OF ATMOSPHERIC PARTICULATES ON THE OCEAN

Background

On a global scale, the total estimated mass of particulate material is 2.5×10^9 tons/year, with almost half this amount in particles of diameter less than 5 microns (1). Man-made emissions contribute approximately 20% of this figure. Particulate transport processes occur predominantly in the troposphere, although some transport is found in the stratosphere followed by settling to the troposphere. The tropospheric circulation is dominantly zonal with three main zones of air mass movement in each hemisphere... the equatorial easterlies, the temperate westerlies and the polar easterlies (2). Arid areas of the continents contribute particulates (dust) to each of these zones. Precipitation scrubbing appears to be the most important mechanism of fallout from the troposphere (3).

Atmospheric particulates may vary in size from grains of sand to short-lived aggregates of a few molecules. Between these limits (approximately 7 orders of magnitude in size) lie the particles that obscure visibility (4), change the distribution of heat in the atmosphere (5), serve as condensation nuclei, make up a large percentage of the sediment in the deep ocean (7-10) and play an important role in the formation of some types of pollution (11-13). Also, regional atmospheric problems can very quickly be transformed into global ones.

There is evidence (14) that as suspended particulates increase in urban atmospheres, death rates do likewise.

Principal factors which control the amount of land-derived dust present in the marine atmosphere are: (a) the strength and circulation of wind systems; (b) weathering characteristics of the local source rocks; (c) the mechanisms by which the dust particles are removed from the atmosphere, for example the efficiency of rain scrubbing or gravitational settling; (d) local input of man-made pollutants (11).

The highest dust loading have been found in the Northeast Trades over the North Atlantic Ocean. In this area the Northeast Trades have a constant direction and cross the Sahara Desert which can supply dust in the form of loose surface deposits (15).

Several investigators (16-18) have attempted to make quantitative estimates of the amount of material transported adjacent to the African landmass. Their collections of atmospheric particulates were made on nylon meshes having an open area of 50%. Dust is collected by impingement and adheres because of the tackiness of the fibers, aided by sea salt spray (19). The collection efficiency has been assumed to be 50% (18), however, recent studies (11) comparing the efficiency of nets versus membranes and electrostatic filters indicate that the true efficiency of these nylon nets approaches 10%. Our sampling program which utilizes high volume air filters capable of retaining all particles down to submicron sizes, will alleviate this problem.

Extensive coverage coupled with enhanced collection efficiency is a prerequisite for estimations of the chemical effect of these particles on seawater. The Northwest Coast of Africa is also an ideal place to measure the effects of particulates on productivity of plankton and fish since these are areas of active upwelling; land-runoff and river discharge are minor contributors to the chemical balance in the area. The dissolution of silica from clay minerals (a major component of the dust) plus the exchange reactions of associated trace metals will be investigated in this study.

METHODS: DESCRIPTION OF DUST COLLECTORS

A) The National Air Surveillance Networks High-Volume Air Sampler (Hi-vol).

The high-volume air sampler, used extensively throughout the United States and other countries of the Western Hemisphere draws air at the rate of 40-60 $ft^3\ min^{-1}$ (1.1-$1.7 m^3 min^{-1}$) through an 8x10" (20.3cm x 25.4cm) glass fiber filter capable of removing nearly 100% of all particulates 0.3μ or greater in diameter. The mass concentration of suspended particulate in the ambient air ($\mu g\ m^{-3}$) is computed from the weight of the particulates collected on the filter and the volume of air sampled.

The Hi-vol sampler basically consists of 3 units: the face plate and gasket, the filter adapter assembly, and the motor unit. The sampling assembly is housed in a shelter and mounted so that the filter is horizontal. A gabled roof protects the filter from precipitation and debris. The air flow rate is determined with a calibrated rotameter attached to a pressure plate located behind the sampling motor. On the assumption that the flow rate decreases uniformly during the sampling period, the volume of air filtered is taken as the product of the time interval, usually 24 hr., and the average of the initial and final flow rates observed during each sampling period.

Collection of atmospheric particulate samples from ships, however, is subject to severe contamination problems. Contamination can arise from direct stack effluents, dirt, paint, or rust from the decks and superstructure carried by wind eddies around the ship. Other sources of contamination are sea salt from bow spray and the pump and filter holder used for the collection. The proposed dust collecting system (described and developed by Moyers, Duce and Hoffman; Atmos. Env. 6, 551, 1972) will attempt to avoid these problems and will essentially consist of a suitably modified Hi-vol sampler mounted on a stand projecting a few meters above and forward of the ships bow.

HI-VOL SAMPLER

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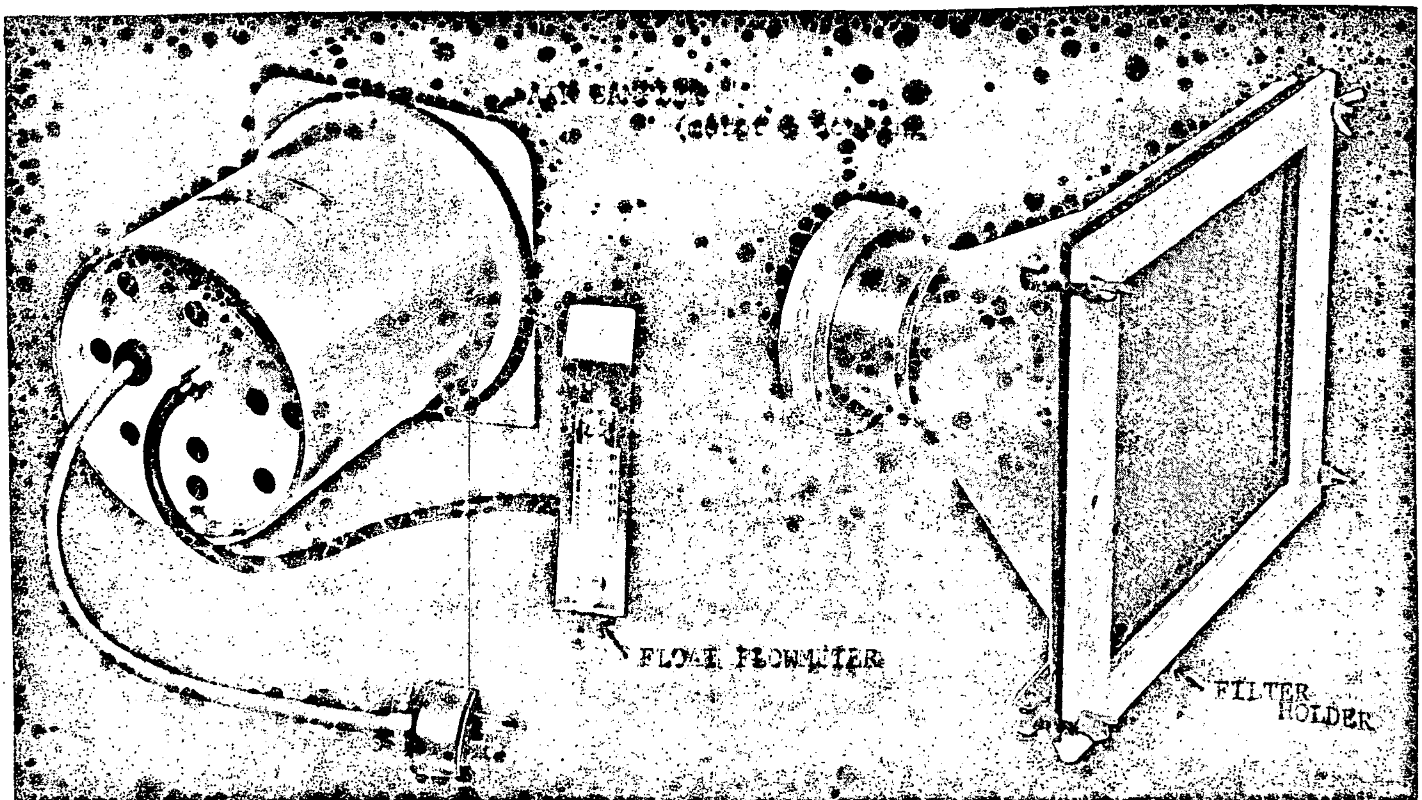

DIMENSIONS:	AIR SAMPLER	23cm diameter x 18cm
	FILTER HOLDER	23cm x 20cm x 20cm
TOTAL WEIGHT:	APPROX. 5 Kg.	
MAINTENANCE:	REPLACE FILTER EVERY 24 HOURS; RECORD FLOW RATE; REPLACE MOTOR BRUSHES APPROXIMATELY EVERY 3 WEEKS.	

B) Anderson Particle Sizing Head (Model 65-000)

The Anderson sampler head has been designed to operate with hi-volume air samplers and adds a new dimension to ambient air sampling by aerodynamically sizing suspended particulate matter. This cascade impactor, operating at a sampling flow rate of 20 ft^3/min separates particles by inertial impaction into five fractions: 7 microns and above, 3.3 to 7.0 microns, 2.0 to 3.3 microns, 1.1 to 2.0 microns and 1.1 to 0.01 microns.

The instrument has been evaluated by the U. S. Public Health Service and Office of Air Programs, Environmental Protection Agency (20) and results of field testing are very favorable, with excellent instrument accuracy and collection efficiency.

Although the size ranges of the Anderson Hi-vol Sampler Head have been selected to simulate the progressive penetration of particles in the human respiratory system for air pollution evaluation, this technique is more valid and practical for the separation, distribution and quantification of airborne particulates than classical physical sizing. In order to determine how a particle will behave in any environment, size, shape and density must be considered. Aerodynamic sizing is the only valid means of determining how a particle will behave in an airstream and how far particulates will travel from their point of origin. By monitoring this size distribution as well as the total particulate loading, predictions can be made concerning the flux of these particulates to the ocean surface in the paths of the various wind systems over the Atlantic Ocean.

Description of Sampler

The Anderson Sampler consists of a series of stacked stages and collection surfaces. Depending on the calibration requirements, each stage contains from 150 to 400 precisely drilled jet orifices identical in diameter in each stage but decreasing in diameter on each succeeding stage. As a constant flow of air is drawn through the sampler, so that as the air passes from stage to stage through the progressively smaller holes, the velocity increases. As the airstream makes a turn at each stage and the particle gains enough inertia to lose the aerodynamic drag it is hurled from the airstream and impacted on the collection surface. The particle is aerodynamically sized the moment it leaves the turning airstream. Adhesive, electrostatic and van der Waals forces hold the particles to each other and to the collection surface.

The collection surfaces to be used are Gelman Type A glass fiber filters (non hygroscopic).

REFERENCES

(1) Peterson, J. T. and C. E. Junge (1970). Sources of particulate matter in the atmosphere. SCEP Report, p. 311-319.

(2) Rex, R. W. and E. D. Goldberg (1962). Insolubles. In M.N. Hill (ed.) "The Sea", 2: 295-304.

(3) Wilkins, E. M. (1958). Precipitation scavenging from atomic bomb clouds at distances of one thousand to two thousand miles. Trans. Amer. Geophys. Union 39: 60-62.

(4) Folger, D. W. (1970). Wind transport of land-derived mineral, biogenic and industrial matter over the North Atlantic. Deep-Sea Res. 17: 337-352 (see references for review).

(5) Plass, G. N. and G. W. Kattawar (1972). Effect of aerosol variation on radiance in the earth's atmosphere-ocean system. Applied Optics 11, 1598-1604.

(6) Radczewski, O. E. (1939). Eolian deposits in marine sediments. In: Parker Track (ed.), Recent Marine Sediments. A Symposium. Amer. Assoc. Petrol. Geol. SEPM Special Publ. No. 4, 736 pp.

(7) Rex, R. W. and E. D. Goldberg (1958). Quartz contents of pelagic sediments of the Pacific Ocean. Tellus 10, 153-159.

(8) Goldberg, E. D. and J. J. Griffin (1969). The sediments of the northern Indian Ocean. Deep-Sea Res. 17, 513-537.

(9) Windom, H. (1969). Atmospheric dust records in permanent snowfields: Implications to marine sedimentation. Bull. Geol. Soc. Amer. 80, 761-782.

(10) Bonatti, E. and G. Arrhenius (1965). Eolian sedimentation in the Pacific off Northern Mexico. Mar. Geol. 3, 337-348.

(11) Goldberg, E. D. (1971). Atmospheric dust, the sedimentary cycle and man. Geophysics 1, 117-132.

(12) Risebrough, R. W., R. J. Huggett, J. J. Griffin and E. D. Goldberg (1968). Pesticides: Transatlantic movements in the Northeast Trades. Science 159, 1233-1236.

(13) Seba, D. B. and J. M. Prospero (1971). Pesticides in the lower atmosphere of the Northern Equatorial Atlantic Ocean. Atmos. Env. 5, 1043-1050.

(14) Lave, L. B. and E. P. Seskin (1970). Air pollution and human health. Science 169, 723-733.

(15) Chester, R. and L. R. Johnson (1971). Atmospheric dusts collected off the Atlantic Coasts of North Africa and the Iberian Peninsula. Mar. Geol. 11, 251-260.

(16) Parkin, D. W. (1969). Airborne dust collections at remote sites. Planet. Space Sci. 17, 575-578.

(17) Parkin, D. W., D. R. Phillips and R. A. L. Sullivan (1970). Airborne dust collections over the Atlantic. J. Geophys. Res. 75, 1782-1793.

(18) Delany, A. C. et al. (1967). Airborne dust collected at Barbados. Geochim. Cosmo. Acta 31, 885-909.

(19) Prospero, J. M. and E. Bonatti (1969). Continental dust in the atmosphere of the eastern equatorial Pacific. J. Geophys. Res. 74, 3362-3371.

(20) Burton, R. M. et al. (1972). Field evaluation of the high-volume particle fractionating cascade impactor--a technique for respirable sampling. J. Air Poll. Control Assn.